BRITISH STANDARD

BS ISO 80000-5:2007

Quantities and units —

Part 5: Thermodynamics

ICS 01.060

British Standards

National foreword

This British Standard was published by BSI. It is the UK implementation of ISO 80000-5:2007. It supersedes BS ISO 31-4:1992 which is withdrawn.

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Quantities and units —

Part 5:
Thermodynamics

Grandeurs et unités —

Partie 5: Thermodynamique

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 80000-5 was prepared by Technical Committee ISO/TC 12, *Quantities, units, symbols, conversion factors*, in collaboration with IEC/TC 25, *Quantities and units, and their letter symbols*.

This first edition cancels and replaces the second edition of ISO 31-4:1992 and ISO 31-4:1992/Amd.1:1998. The major technical changes from the previous standards are the following:

— the presentation of *numerical statements* has been changed;

— the *normative references* have been changed;

— some quantities concerning moisture have been added at the end of the list of quantities.

ISO 80000 consists of the following parts, under the general title *Quantities and units*:

— *Part 1: General*

— *Part 2: Mathematical signs and symbols to be used in the natural sciences and technology*

— *Part 3: Space and time*

— *Part 4: Mechanics*

— *Part 5: Thermodynamics*

— *Part 7: Light*

— *Part 8: Acoustics*

— *Part 9: Physical chemistry and molecular physics*

— *Part 10: Atomic and nuclear physics*

— *Part 11: Characteristic numbers*

— *Part 12: Solid state physics*

IEC 80000 consists of the following parts, under the general title *Quantities and units*:

— *Part 6: Electromagnetism*

— *Part 13: Information science and technology*

— *Part 14: Telebiometrics related to human physiology*

Introduction

0.1 Arrangements of the tables

The tables of quantities and units in this International Standard are arranged so that the quantities are presented on the left-hand pages and the units on the corresponding right-hand pages.

All units between two full lines on the right-hand pages belong to the quantities between the corresponding full lines on the left-hand pages.

Where the numbering of an item has been changed in the revision of a part of ISO 31, the number in the preceding edition is shown in parentheses on the left-hand page under the new number for the quantity; a dash is used to indicate that the item in question did not appear in the preceding edition.

0.2 Tables of quantities

The names in English and in French of the most important quantities within the field of this International Standard are given together with their symbols and, in most cases, their definitions. These names and symbols are recommendations. The definitions are given for identification of the quantities in the International System of Quantities (ISQ), listed on the left-hand pages of the table; they are not intended to be complete.

The scalar, vectorial or tensorial character of quantities is pointed out, especially when this is needed for the definitions.

In most cases only one name and only one symbol for the quantity are given; where two or more names or two or more symbols are given for one quantity and no special distinction is made, they are on an equal footing. When two types of italic letters exist (for example as with ϑ and θ; φ and ϕ; *a* and a; *g* and g) only one of these is given. This does not mean that the other is not equally acceptable. It is recommended that such variants should not be given different meanings. A symbol within parentheses implies that it is a reserve symbol, to be used when, in a particular context, the main symbol is in use with a different meaning.

In this English edition, the quantity names in French are printed in an italic font, and are preceded by *fr*. The gender of the French name is indicated by (m) for masculine and (f) for feminine, immediately after the noun in the French name.

0.3 Tables of units

0.3.1 General

The names of units for the corresponding quantities are given together with the international symbols and the definitions. These unit names are language-dependent, but the symbols are international and the same in all languages. For further information, see the SI Brochure (8th edition 2006) from BIPM and ISO 80000-1[1)].

The units are arranged in the following way:

a) The coherent SI units are given first. The SI units have been adopted by the General Conference on Weights and Measures (Conférence Générale des Poids et Mesures, CGPM). The use of coherent SI units

1) To be published.

is recommended; decimal multiples and submultiples formed with the SI prefixes are recommended even though not explicitly mentioned.

b) Some non-SI units are then given, being those accepted by the International Committee for Weights and Measures (Comité International des Poids et Mesures, CIPM), or by the International Organization of Legal Metrology (Organisation Internationale de Métrologie Légale, OIML), or by ISO and IEC, for use with the SI.

   Such units are separated from the SI units in the item by use of a broken line between the SI units and the other units.

c) Non-SI units currently accepted by the CIPM for use with the SI are given in small print (smaller than the text size) in the "Conversion factors and remarks" column.

d) Non-SI units that are not recommended are given only in annexes in some parts of this International Standard. These annexes are informative, in the first place for the conversion factors, and are not integral parts of the standard. These deprecated units are arranged in two groups:

   1) units in the CGS system with special names;

   2) units based on the foot, pound, second, and some other related units.

e) Other non-SI units given for information, especially regarding the conversion factors, are given in another informative annex.

0.3.2 Remark on units for quantities of dimension one, or dimensionless quantities

The coherent unit for any quantity of dimension one, also called a dimensionless quantity, is the number one, symbol 1. When the value of such a quantity is expressed, the unit symbol 1 is generally not written out explicitly.

EXAMPLE 1 Refractive index $n = 1{,}53 \times 1 = 1{,}53$

Prefixes shall not be used to form multiples or submultiples of this unit. Instead of prefixes, powers of 10 are recommended.

EXAMPLE 2 Reynolds number $Re = 1{,}32 \times 10^3$

Considering that plane angle is generally expressed as the ratio of two lengths and solid angle as the ratio of two areas, in 1995 the CGPM specified that, in the SI, the radian, symbol rad, and steradian, symbol sr, are dimensionless derived units. This implies that the quantities plane angle and solid angle are considered as derived quantities of dimension one. The units radian and steradian are thus equal to one; they may either be omitted, or they may be used in expressions for derived units to facilitate distinction between quantities of different kinds but having the same dimension.

0.4 Numerical statements in this International Standard

The sign $=$ is used to denote "is exactly equal to", the sign $\approx$ is used to denote "is approximately equal to", and the sign $:=$ is used to denote "is by definition equal to".

Numerical values of physical quantities that have been experimentally determined always have an associated measurement uncertainty. This uncertainty should always be specified. In this International Standard, the magnitude of the uncertainty is represented as in the following example.

EXAMPLE $l = 2{,}347\,82(32)$ m

In this example, $l = a(b)$ m, the numerical value of the uncertainty b indicated in parentheses is assumed to apply to the last (and least significant) digits of the numerical value a of the length l. This notation is used when b represents the standard uncertainty (estimated standard deviation) in the last digits of a. The numerical example given above may be interpreted to mean that the best estimate of the numerical value of the length l (when l is expressed in the unit metre) is 2,347 82, and that the unknown value of l is believed to lie between $(2{,}347\,82 - 0{,}000\,32)$ m and $(2{,}347\,82 + 0{,}000\,32)$ m with a probability determined by the standard uncertainty 0,000 32 m and the normal probability distribution of the values of l.

Quantities and units —

Part 5:
Thermodynamics

1 Scope

ISO 80000-5 gives names, symbols and definitions for quantities and units of thermodynamics. Where appropriate, conversion factors are also given.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 80000-3:2006, *Quantities and units — Part 3: Space and time*[2)]

ISO 80000-4:2006, *Quantities and units — Part 4: Mechanics*[3)]

ISO 31-0:1992, *Quantities and units — Part 0: General principles*[4)]

ISO 31-8:1992, *Quantities and units — Part 8: Physical chemistry and molecular physics*[5)]

3 Names, symbols, and definitions

The names, symbols, and definitions for quantities and units of thermodynamics are given on the following pages.

2) Revision of ISO 31-1:1992 and ISO 31-2:1992.

3) Revision of ISO 31-3:1992.

4) To be revised as ISO 80000-1.

5) To be revised as ISO 80000-9.

THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-1 (*4-1*)	thermodynamic temperature *fr température* (f) *thermo-dynamique*	T, (Θ)	one of the base quantities in the International System of Quantities, ISQ, on which the International System of Units, SI, is based	Thermodynamic temperature is the quantity that is measured with a primary thermometer, examples of which are constant volume gas thermometers, acoustic thermometers, or total radiation thermometers.
5-2 (*4-2*)	Celsius temperature *fr température* (f) *Celsius*	t, ϑ	$t = T - T_0$ where T is thermodynamic temperature (item 5-1) and $T_0 :=$ 275,15 K	The thermodynamic temperature T_0 is exactly 0,01 K below the thermodynamic temperature of the triple point of water.

UNITS				THERMODYNAMICS
Item No.	**Name**	**International symbol**	**Definition**	**Conversion factors and remarks**
5-1.a	kelvin	K	unit of thermodynamic temperature that is the fraction 1/273,16 of the thermodynamic temperature of the triple point of water	The units of thermodynamic and Celsius temperature difference or change are identical. Such differences or changes may be expressed either in kelvins, symbol K, or in degrees Celsius, symbol, °C.
5-2.a	degree Celsius	°C	special name for the kelvin for use in stating values of Celsius temperature 1 °C := 1 K	It should be noted that the symbol °C for the degree Celsius shall be preceded by a space (see ISO 31-0, 3.4). **The International Temperature Scale of 1990** For the purpose of practical measurements, the International Temperature Scale of 1990, ITS-90, was adopted by CIPM in 1989. The quantities corresponding to thermodynamic temperature and Celsius temperature defined by this scale are denoted T_{90} and t_{90}, respectively (replacing T_{68} and t_{68} defined by the International Practical Temperature Scale of 1968, IPTS-68), where $t_{90} = T_{90} - T_0$ The units of T_{90} and t_{90} are the kelvin, symbol K, and the degree Celsius, symbol °C, respectively. For further information, see: The International Temperature Scale of 1990 (ITS-90), *Metrologia*, **27** (1990), No. 1. The definition of the kelvin refers to water having the isotopic composition defined exactly by the following amount-of-substance ratios: 0,000 155 76 mole of ^2H per mole of ^1H; 0,000 379 9 mole of ^{17}O per mole of ^{16}O; and 0,002 005 2 mole of ^{18}O per mole of ^{16}O.

(*continued*)

THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-3.1 (*4-3.1*)	linear expansion coefficient *fr coefficient* (m) *de dilatation linéique*	α_l	$\alpha_l = \frac{1}{l}\frac{\mathrm{d}l}{\mathrm{d}T}$ where l is length (ISO 80000-3:2006, item 3-1.1) and T is thermodynamic temperature (item 5-1)	The subscripts in the symbols for items 5-3.3 to 5-5.2 may be omitted when there is no risk of confusion.
5-3.2 (*4-3.2*)	cubic expansion coefficient *fr coefficient* (m) *de dilatation volumique*	α_V, α, γ	$\alpha_V = \frac{1}{V}\frac{\mathrm{d}V}{\mathrm{d}T}$ where V is volume (ISO 80000-3:2006, item 3-4) and T is thermodynamic temperature (item 5-1)	
5-3.3 (*4-3.3*)	relative pressure coefficient *fr coefficient* (m) *relatif de pression*	α_p	$\alpha_p = \frac{1}{p}\left(\frac{\partial p}{\partial T}\right)_V$ where p is pressure (ISO 80000-4:2006, item 4-15.1), T is thermodynamic temperature (item 5-1), and V is volume (ISO 80000-3:2006, item 3-4)	
5-4 (*4-4*)	pressure coefficient *fr coefficient* (m) *de pression*	β	$\beta = \left(\frac{\partial p}{\partial T}\right)_V$ where p is pressure (ISO 80000-4:2006, item 4-15.1), T is thermodynamic temperature (item 5-1), and V is volume (ISO 80000-3:2006, item 3-4)	
5-5.1 (*4-5-1*)	isothermal compressibility *fr compressibilité* (f) *isotherme*	$\varkappa_T$	$\varkappa_T = \frac{1}{V}\left(\frac{\partial V}{\partial p}\right)_T$ where V is volume (ISO 80000-3:2006, item 3-4), p is pressure (ISO 80000-4:2006, item 4-15.1)	T is thermodynamic temperature (item 5-1).
5-5.2 (*4-5.2*)	isentropic compressibility *fr compressibilité* (f) *isentropique*	$\varkappa_S$	$\varkappa_S = \frac{1}{V}\left(\frac{\partial V}{\partial p}\right)_S$ where V is volume (ISO 80000-3:2006, item 3-4), p is pressure (ISO 80000-4:2006, item 3-1.1)	S is entropy (item 5-18).

UNITS				THERMODYNAMICS
Item No.	**Name**	**International symbol**	**Definition**	**Conversion factors and remarks**
5-3.a	kelvin to the power minus one	K^{-1}		
5-4.a	pascal per kelvin	Pa/K		For the unit pascal, see ISO 80000-4:2006, item 4-15.a.
5-5.a	pascal to the power minus one	Pa^{-1}		

(*continued*)

THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-6 (*4-6*)	heat, amount of heat *fr quantité* (f) *de chaleur*, *chaleur* (f)	Q	difference between the increase in the total energy (item 5-20.1) of a physical system and the work done on the system, provided that the amounts of substances within the system are not changed	The heat transferred in an isothermal phase transformation should be expressed as the change in the appropriate thermodynamic functions, e.g. $T \cdot \Delta S$, where T is thermodynamic temperature (item 5-1) and S is entropy (item 5-18), or ΔH, where H is enthalpy (item 5-20.3). NOTE A supply of heat may correspond to an increase in thermodynamic temperature or to other effects, such as phase change or chemical processes.
5-7 (*4-7*)	heat flow rate *fr flux* (m) *thermique*	Φ	rate at which heat (item 5-6) crosses a given surface	
5-8 (*4-8*)	areic heat flow rate, density of heat flow rate *fr densité* (f) *de flux thermique*, *flux thermique surfacique*	q, φ	$q = \Phi / A$ where Φ is heat flow rate (item 5-7) and A is area (ISO 80000-3:2006, item 3-3)	
5-9 (*4-9*)	thermal conductivity *fr conductivité* (f) *thermique*	λ, ($\varkappa$)	areic heat flow rate (item 5-8) divided by temperature (item 5-1) gradient	
5-10.1 (*4-10.1*)	coefficient of heat transfer *fr coefficient* (m) de *transmission thermique*	K, (k)	areic heat flow rate (item 5-8) divided by thermodynamic temperature (item 5-1) difference	In building technology, the coefficient of heat transfer is often called thermal transmittance, with the symbol U.
5-10.2 (*4-10.2*)	surface coefficient of heat transfer *fr coefficient* (m) de *transmission thermique de surface*	h, (α)	$q = h(T_\mathrm{s} - T_\mathrm{r})$ where q is areic heat flow rate (item 5-8), T_s is the thermodynamic temperature (item 5-1) of the surface, and T_r is a reference thermodynamic temperature characteristic of the adjacent surroundings	

UNITS				THERMODYNAMICS
Item No.	**Name**	**International symbol**	**Definition**	**Conversion factors and remarks**
5-6.a	joule	J		For the unit joule, see ISO 80000-4:2006, item 4-27.a.
5-7.a	watt	W		
5-8.a	watt per square metre	W/m^2		
5-9.a	watt per metre kelvin	$W/(m \cdot K)$		
5-10.a	watt per square metre kelvin	$\frac{W}{m^2 \cdot K}$		

(*continued*)

THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-11 (*4-11*)	thermal insulance, coefficient of thermal insulance *fr coefficient* (m) *d'isolation thermique*	M	$M = 1/K$ where K is coefficient of heat transfer (item 5-10.1)	In building technology, this quantity is often called thermal resistance, with the symbol R.
5-12 (*4-12*)	thermal resistance *fr résistance* (f) *thermique*	R	thermodynamic temperature (item 5-1) difference divided by heat flow rate (item 5-7)	See remark to 5-11.
5-13 (*4-13*)	thermal conductance *fr conductance* (f) *thermique*	G, (H)	$G = 1/R$ where R is thermal resistance (item 5-12)	See remark to 5-11. This quantity is also called heat transfer coefficient.
5-14 (*4-14*)	thermal diffusivity *fr diffusivité* (f) *thermique*	α	$\alpha = \dfrac{\lambda}{\rho c_p}$ where λ is thermal conductivity (item 5-9), ρ is mass density (ISO 80000-4:2006, item 4-2), and c_p is specific heat capacity at constant pressure (item 5-16.2)	
5-15 (*4-15*)	heat capacity *fr capacité* (f) *thermique*	C	when the thermodynamic temperature of a system is increased by dT as a result of the addition of a small amount of heat dQ, $C = \mathrm{d}Q/\mathrm{d}T$ where Q is amount of heat (item 5-6) and T is thermodynamic temperature (item 5-1)	Heat capacity is not completely defined unless the type of change is specified.

UNITS				THERMODYNAMICS
Item No.	**Name**	**Inter-national symbol**	**Definition**	**Conversion factors and remarks**
5-11.a	square metre kelvin per watt	$m^2 \cdot K/W$		
5-12.a	kelvin per watt	K/W		
5-13.a	watt per kelvin	W/K		
5-14.a	square metre per second	m^2/s		
5-15.a	joule per kelvin	J/K		

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THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-16.1 (*4-16.1*)	specific heat capacity *fr capacité* (f) *thermique massique*	c	heat capacity (item 5-15) divided by mass (ISO 80000-4:2006, item 4-1)	For the corresponding molar quantities, see ISO 31-8:1992.
5-16.2 (*4-16.2*)	specific heat capacity at constant pressure *fr capacité* (f) *thermique massique à pression constante*	c_p		
5-16.3 (*4-16.3*)	specific heat capacity at constant volume *fr capacité* (f) *thermique massique à volume constant*	c_V		
5-16.4 (*4-16.4*)	specific heat capacity at saturation *fr capacité* (f) *thermique massique à saturation*	c_{sat}		
5-17.1 (*4-17.1*)	ratio of the specific heat capacities *fr rapport* (m) *des capacités thermiques massiques*	γ	$\gamma = c_p/c_V$ where c_p is specific heat capacity at constant pressure (item 5-16.2) and c_V is specific heat capacity at constant volume (item 5-16.3)	
5-17.2 (*4-17.2*)	isentropic exponent *fr exposant* (m) *isentropique*	$\varkappa$	$\varkappa = -\dfrac{V}{p}\left(\dfrac{\partial p}{\partial V}\right)_S$ where V is volume (ISO 80000-3:2006, item 3-4), p is pressure (ISO 80000-4:2006, item 4-15.1), and S is entropy (item 5-18)	For an ideal gas, $\varkappa$ is equal to γ.

UNITS				THERMODYNAMICS
Item No.	**Name**	**International symbol**	**Definition**	**Conversion factors and remarks**
5-16.a	joule per kilogram kelvin	$J/(kg \cdot K)$		
5-17.a	one	1		See the Introduction, 0.3.2.

(*continued*)

THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-18 (*4-18*)	entropy *fr entropie* (f)	S	when a small amount of heat (item 5-6) dQ is received by a system whose thermodynamic temperature (item 5-1) is T, the entropy of the system increases by dQ/T, provided that no irreversible change takes place in the system	
5-19 (*4-19*)	specific entropy *fr entropie* (f) *massique*	s	$s = S/m$ where S is entropy (item 5-18) and m is mass (ISO 80000-4:2006, item 4-1)	For the corresponding molar quantities, see ISO 31-8:1992.
5-20.1 (*4-20.1*)	energy *fr énergie* (f)	E	quantity characterizing the ability of a system to do work (ISO 80000-4:2006, item 4-27.1)	Energy exists in different forms that are mutually transformable into each other, either totally or partially.
5-20.2 (*4-20.2*)	internal energy, thermodynamic energy *fr énergie* (f) *interne, énergie* (f) *thermo-dynamique*	U	for a closed thermodynamic system, $\Delta U = Q + W$ where Q is amount of heat (item 5-6) transferred to the system and W is work (ISO 80000-4:2006, item 4-27.1) done on the system provided that no chemical reactions occur	
5-20.3 (*4-20.3*)	enthalpy *fr enthalpie* (f)	H	$H = U + pV$ where U is internal energy (item 5-20.2), p is pressure (ISO 80000-4:2006, item 4-15.1), and V is volume (ISO 80000-3:2006, item 3-4)	
5-20.4 (*4-20.4*)	Helmholtz energy, Helmholtz function *fr énergie* (f) *libre*	A, F	$A = U - TS$ where U is internal energy (item 5-20.2), T is thermodynamic temperature (item 5-1), and S is entropy (item 5-18)	The name Helmholtz free energy is also used.
5-20.5 (*4-20.5*)	Gibbs energy, Gibbs function *fr enthalpie* (f) *libre*	G	$G = H - TS$ where H is enthalpy (item 5-20.3), T is thermodynamic temperature (item 5-1), and S is entropy (item 5-18)	The name Gibbs free energy is also used.

UNITS				THERMODYNAMICS
Item No.	**Name**	**International symbol**	**Definition**	**Conversion factors and remarks**
5-18.a	joule per kelvin	J/K		
5-19.a	joule per kilogram kelvin	$J/(kg \cdot K)$		
5-20.a	joule	J		

(*continued*)

THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-21.1 (*4-21.1*)	specific energy *fr énergie* (f) *massique*	e	$e = E/m$ where E is energy (item 5-20.1) and m is mass (ISO 80000-4:2006, item 4-1)	
5-21.2 (*4-21.2*)	specific internal energy, specific thermodynamic energy *fr énergie* (f) *interne massique*, *énergie* (f) *thermo-dynamique massique*	u	$u = U/m$ where U is thermodynamic energy (item 5-20.2) and m is mass (ISO 80000-4:2006, item 4-1)	
5-21.3 (*4-21.3*)	specific enthalpy *fr enthalpie* (f) *massique*	h	$h = H/m$ where H is enthalpy (item 5-20.3) and m is mass (ISO 80000-4:2006, item 4-1)	
5-21.4 (*4-21.4*)	specific Helmholtz energy, specific Helmholtz function *fr énergie* (f) *libre massique*	a, f	$a = A/m$ where A is Helmholtz energy (item 5-20.4) and m is mass (ISO 80000-4:2006, item 4-1)	The name specific Helmholtz free energy is also used.
5-21.5 (*4-21.5*)	specific Gibbs energy, specific Gibbs function *fr enthalpie* (f) *libre massique*	g	$g = G/m$ where G is Gibbs energy (item 5-20.5) and m is mass (ISO 80000-4:2006, item 4-1)	The name specific Gibbs free energy is also used.
5-22 (*4-22*)	Massieu function *fr fonction* (f) *de Massieu*	J	$J = -A/T$ where A is Helmholtz energy (item 5-20.4) and T is thermodynamic temperature (item 5-1)	
5-23 (*4-23*)	Planck function *fr fonction* (f) *de Planck*	Y	$Y = -G/T$ where G is Gibbs energy (item 5-20.5) and T is thermodynamic temperature (item 5-1)	

UNITS				THERMODYNAMICS
Item No.	**Name**	**International symbol**	**Definition**	**Conversion factors and remarks**
5-21.a	joule per kilogram	J/K		
5-22.a	joule per kelvin	J/K		
5-23.a	joule per kelvin	J/K		

(*continued*)

THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-24 (—)	mass concentration of water *fr concentration* (f) *en masse d'humidité*	w	$w = m/V$ where m is mass (ISO 80000-4:2006, item 4-1) of water, irrespective of the form of aggregation, and V is volume (ISO 80000-3:2006, item 3-4)	Mass concentration of water at saturation is denoted w_{sat}.
5-25 (—)	mass concentration of water vapour *fr concentration* (f) *en masse de vapeur d'eau*	v	$v = m/V$ where m is mass (ISO 80000-4:2006, item 4-1) of water vapour and V is total gas volume (ISO 80000-3:2006, item 3-4)	Mass concentration of water vapour at saturation is denoted v_{sat}.
5-26 (—)	mass ratio of water to dry matter *fr rapport* (m) *de la masse d'humidité à la masse de matière sèche*	u	$u = m/m_{\mathrm{d}}$ where m is mass (ISO 80000-4:2006, item 4-1) of water and m_{d} is mass of dry matter	Mass ratio of water to dry matter at saturation is denoted u_{sat}.
5-27 (—)	mass ratio of water vapour to dry gas *fr rapport* (m) *de la masse de vapeur d'eau à la masse de gaz sec*	x	$x = m/m_{\mathrm{d}}$ where m is mass (ISO 80000-4:2006, item 4-1) of water vapour and m_{d} is mass of dry gas	Mass ratio of water vapour to dry gas at saturation is denoted x_{sat}.
5-28 (—)	mass fraction of water *fr fraction* (f) *massique d'humidité*	$w_{\mathrm{H_2O}}$	$w_{\mathrm{H_2O}} = \dfrac{u}{1+u}$ where u is mass ratio of water to dry matter (item 5-26)	
5-29 (—)	mass fraction of dry matter *fr fraction* (f) *massique de matière sèche*	w_{d}	$w_{\mathrm{d}} = 1 - w_{\mathrm{H_2O}}$ where $w_{\mathrm{H_2O}}$ is mass fraction of water (item 5-28)	
5-30 (—)	relative partial pressure, relative humidity *fr humidité* (f) *relative*	φ	$\varphi = p/p_{\mathrm{sat}}$ where p is partial pressure (ISO 80000-4:2006, item 4-15.1) of vapour and p_{sat} is its partial pressure at saturation (at the same temperature)	Relative partial pressure is often referred to as RH and expressed in percent.

UNITS				THERMODYNAMICS
Item No.	**Name**	**International symbol**	**Definition**	**Conversion factors and remarks**
5-24.a	kilogram per cubic metre	kg/m^3		
5-25.a	kilogram per cubic metre	kg/m^3		
5-26.a	one	1		See the Introduction, 0.3.2.
5-27.a	one	1		See the Introduction, 0.3.2.
5-28.a	one	1		See the Introduction, 0.3.2.
5-29.a	one	1		See the Introduction, 0.3.2.
5-30.a	one	1		See the Introduction, 0.3.2.

(*continued*)

THERMODYNAMICS				QUANTITIES
Item No.	**Name**	**Symbol**	**Definition**	**Remarks**
5-31 (—)	relative mass concentration of vapour *fr concentration* (f) *relative en masse de vapeur d'eau*	φ	$\varphi = v/v_{\text{sat}}$ where v is mass concentration of water vapour (item 5-25) and v_{sat} is its mass concentration of water vapour at saturation (at the same temperature)	For normal cases, the relative partial pressure (item 5-30) may be assumed to be equal to relative mass concentration of vapour.
5-32 (—)	relative mass ratio of vapour *fr rapport* (m) *relatif de masse de vapeur*	ψ	$\psi = x/x_{\text{sat}}$ where x is mass ratio of water vapour to dry gas (item 5-27) and x_{sat} is its mass ratio of water vapour to dry gas at saturation (at the same temperature)	
5-33 (—)	dew point temperature *fr température* (f) *du point de rosée, température* (f) *de rosée*	T_{d}	temperature at which vapour in the air reaches saturation	The corresponding Celsius temperature is denoted t_{d}. This quantity is also called dew point.

UNITS				THERMODYNAMICS
Item No.	**Name**	**International symbol**	**Definition**	**Conversion factors and remarks**
5-31.a	one	1		See the Introduction, 0.3.2.
5-32.a	one	1		See the Introduction, 0.3.2.
5-33.a	kelvin	K		The unit for the corresponding Celsius temperature is degree Celsius, symbol °C.

(*concluded*)

Annex A
(informative)

Units based on the foot, pound, second, and some other related units

The use of these units is deprecated.

Quantity item No.	Quantity	Unit item No.	Name of unit with symbol	Conversion factors and remarks
5-1	thermodynamic temperature: T	5-1.A.a	degree Rankine: °R	$1\,°\mathrm{R} := \frac{5}{9}\,\mathrm{K}$ The symbol °R for the degree Rankine shall be preceded by a space.
—	Fahrenheit temperature: t_F	5-2.A.a	degree Fahrenheit: °F	$\frac{t_\mathrm{F}}{°\mathrm{F}} := \frac{9}{5}\frac{t}{°\mathrm{C}} + 32 = \frac{9}{5}\frac{T}{\mathrm{K}} - 459{,}67$ The unit degree Fahrenheit is identical to the unit degree Rankine. The symbol °F for the degree Fahrenheit shall be preceded by a space.
5-6	heat, amount of heat	5-6.A.a	British thermal unit: Btu	$1\,\mathrm{Btu} := 788{,}169\,\mathrm{ft}\cdot\mathrm{lbf} \approx 1\,055{,}056\,\mathrm{J}$ As well as this, a number of “British thermal units” were previously used.
5-7	heat flow rate	5-7.A.a	British thermal unit per hour: Btu/h	$1\,\mathrm{Btu/h} \approx 0{,}293\,071\,\mathrm{W}$
5-9	thermal conductivity	5-9.A.a	British thermal unit per second foot degree Rankine: Btu/(s·ft·°R)	$1\,\mathrm{Btu/(s\cdot ft\cdot °R)} \approx 6\,230{,}64\,\mathrm{W/(m\cdot K)}$
5-10	coefficient of heat transfer	5-10.A.a	British thermal unit per second square foot degree Rankine: Btu/(s·ft^2·°R)	$1\,\mathrm{Btu/(s\cdot ft^2\cdot °R)} \approx 20\,441{,}7\,\mathrm{W/(m^2\cdot K)}$
		5-10.A.b	British thermal unit per hour square foot degree Rankine: Btu/(h·ft^2·°R)	$1\,\mathrm{Btu/(h\cdot ft^2\cdot °R)} \approx 5{,}678\,26\,\mathrm{W/(m^2\cdot K)}$
5-14	thermal diffusivity	5-14.A.a	square foot per second: ft^2/s	$1\,\mathrm{ft^2/s} = 0{,}092\,903\,04\,\mathrm{m^2/s}$

(*continued*)

Quantity item No.	Quantity	Unit item No.	Name of unit with symbol	Conversion factors and remarks
5-16.1	specific heat capacity	5-16.A.a	British thermal unit per pound degree Rankine: Btu/(lb · °R)	1 Btu/(lb·°R) = 4 186,8 J/(kg·K)
5-19	specific entropy	5-19.A.a	British thermal unit per pound degree Rankine: Btu/(lb · °R)	1 Btu/(lb·°R) = 4 186,8 J/(kg·K)
5-21.1 5-21.2 5-21.3 5-21.4 5-21.5	specific energy specific thermodynamic energy specific enthalpy specific Helmholtz energy specific Gibbs energy	5-21.A.a	British thermal unit per pound: Btu/lb	1 Btu/lb = 2 326 J/kg

(*concluded*)

Annex B
(informative)

Other non-SI units given for information, especially regarding the conversion factors

The use of these units is deprecated.

Quantity item No.	Quantity	Unit item No.	Name of unit with symbol	Conversion factors and remarks
5-6	heat, amount of heat	5-6.B.a	15 °C calorie: cal_{15}	1 cal_{15} is the amount of heat required to warm 1 g of air-free water from 14,5 °C to 15,5 °C at a constant pressure of 101,325 kPa. $1\ \mathrm{cal}_{15} \approx 4{,}185\,5(5)\ \mathrm{J}$
		5-6.B.b	I.T. calorie: $\mathrm{cal}_{\mathrm{IT}}$	$1\ \mathrm{cal}_{\mathrm{IT}} := 4{,}186\,8\ \mathrm{J}$ $1\ \mathrm{Mcal}_{\mathrm{IT}} := 1{,}163\ \mathrm{kW \cdot h}$
		5-6.B.c	thermo-chemical calorie: $\mathrm{cal}_{\mathrm{th}}$	$1\ \mathrm{cal}_{\mathrm{th}} := 4{,}184\ \mathrm{J}$

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